General Overview and Installation of Light Traps in Broiler Breeder Rearing

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Designing a ventilation system for a dark out tunnel ventilated rearing house can be challenging. There are many different models and designs of light traps available, each with different light restriction capacities. The air flow restriction does not necessarily correspond with the light reduction factor. Some light traps with very high light reduction factors have very low air flow restriction. The amount or area of light trap needed will primarily depend on the fan capacity needed to achieve the target house velocity.

Light traps or light filters can be compared in terms of two criteria:

Resistance to airflow:

Resistance to air flow is usually presented in graphical format with static pressure (in Pascals (Pa) or inches of water column (in wc)) plotted against light trap face velocity in meters per second (m/s) or feet per minute (fpm). When comparing light traps at a given face velocity, a lower static pressure will indicate a lower air flow resistance.

Resistance to light transmission:

Test facilities will place high wattage lamps outside the light traps to simulate direct sunlight. Light intensity is measured at the outside and inside surfaces of the light traps. The light reduction factor is calculated by dividing the outside light intensity by the inside light intensity.

When comparing different light traps/filters, the higher the light reduction factor, the greater the resistance to light transmission. The light trap should have a light reduction factor of at least 2,000,000 to one. Ideally it should be in excess of 10,000,000 to one.

An excellent reference can be found at http://bess.illinois.edu/pdf/Lighttraps.pdf

SOME GENERAL LIGHT TRAP CHOICES AND INSTALLATION TIPS

A. Light traps are available in both a cellular and blade design. Blade or vane type light traps are suitable for fan installations. They must be installed with the vanes vertically orientated to prevent dust accumulation. Cellular types are not suitable for fan installations, but can be used in perimeter and tunnel inlets. Cellular types are more difficult to clean and disinfect.

B. Light traps placed directly over fans will cause a significant drop in fan performance, thus they are not the best option in a high-speed tunnel houses. In a cross ventilated pullet house, a 150 cm × 150 cm or 2.25 m^2 (60 in x 60 in or 25 ft^2) light trap can be placed directly over a standard 120 cm fan (48 in). The light trap must be mounted at least 25 cm (10 in) from the fan shutter.

C. When installing both tunnel inlet light traps and evaporative pads in a pullet rearing house, the tunnel inlet light traps can have a lower light reduction factor and lower air flow resistance than those installed at the tunnel fan end, due to the light reduction factor offered by the evaporative pads and a darkened dog house (painted black or the use of shade cloth).

D. An efficient installation option for the tunnel fan light traps, is to construct a false wall that incorporates the light traps, placed 1.5 m (5 ft) from the tunnel fan end. This allows air to pass through all light traps reducing the pressure drop when the house is not in full tunnel mode.

A. A light trap in a blade design.

B. Light traps mounted over fans can reduce fan performance, and are not the best option in high-speed tunnel houses.

C. Tunnel inlet light trap.

D. Light trap in a false wall in front of tunnel fans.

SOME GENERAL LIGHT TRAP CHOICES AND INSTALLATION TIPS

E. An alternative is to install the tunnel fans on the sides of the house, each with a plenum type room (doghouse) for the installation of the light trap false walls. This is by far the most efficient, since fan and light trap area requirements in high speed rearing houses usually require more light trap area than can fit into the house cross section.

E. Tunnel fan light trap false wall installed in a vestibule plenum (dog house) in front of tunnel fans installed on the sides of the house.

F. Perimeter inlet light traps are installed in a windproof box/cover on the outside of the house. The cross sectional area of this box/cover should be at least 30 % larger than the perimeter inlet itself. The light traps are similarly sized to fit into the opening of the box/ cover.

F. A perimeter inlet light traps installed in a box or wind proof cover.

When using evaporative pads, a shaded inlet area (similar to the images shown above) can eliminate the need for inlet light traps. Alternatively, the best option would be to use a light trap with a considerably lower light reduction factor and pressure drop.

House air velocity standards:

Pullet house air velocity requirement:	2.0 to 2.5 m/s (400 to 500 fpm)
Rear, grow, lay house air velocity requirement:	2.5 m/s to 3.0 m/s (500 to 600 fpm)

Estimated transition pressures and pipe pressure along the length of the house (per 30 m (100 ft)) with varying tunnel air speeds

Tunnel Speeds		Transition pressure		Pipe pressure (per 30 m (100ft))	
m/s	fpm	Pa	in wc	Pa	in wc
2.0	400	5	0.02	0.87	0.0035
2.5	500	7.5	0.03	1.5	0.006

Operating pressure drops standards:

- The target pressure drop across the tunnel inlet light trap is 5 Pa (0.02 in wc). This will vary depending on suppliers and the required light reduction factor.
- The installation of an evaporative cooling system increases the pressure drop by 12.5 Pa (0.05 in wc).
- Generally the transition pressure drop (turn pressure drop, caused by drawing incoming air through a large inlet area and squeezing it into the smaller house cross section) will contribute a combined 5.0 to 7.5 Pa (0.02 to 0.03 in wc).
- Pipe pressure produced as the air moves down the length of the house will depend on velocity– see table above for estimates per 30 m (100 ft) of house length.
- Any extra equipment or obstructions over the length of the house could also potentially increase the house pipe pressure – if possible, do not use obstructive equipment. This is particularly relevant for combined rearing and production houses. Therefore, if possible, keep nest boxes outside the house during rearing.
- The target pressure drop across the tunnel fan light trap is 20 Pa (0.08 in wc) (This will vary depending on suppliers and the required light reduction factor).
- When installing light traps, it is very important to know the pressure drop across the light trap. Use this information to ensure the correct fan capacity is installed to meet the air velocity requirements of the flock.
- The light trap supplier will supply the expected pressure drops (Pa or in wc) over a range of face velocities (m/s or fpm).
- The airspeed or face velocity of the light trap is a representation of its area relative the total tunnel fan operating capacity. (See illustration on page 8).
- Ideally the sum of all the pressure drops, or the total amount of work the fans need to do, should not exceed 37.5 Pa (0.15 in wc).

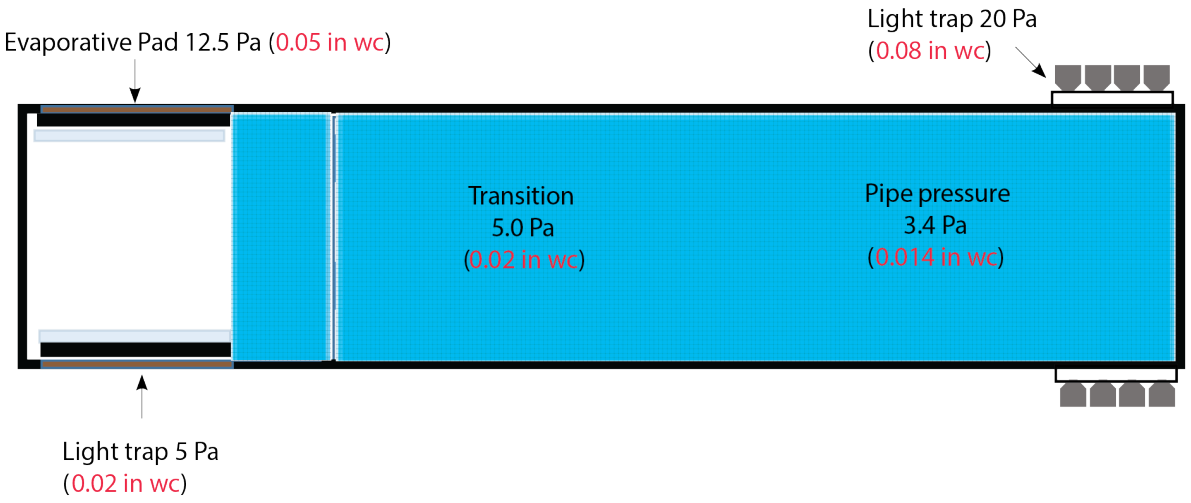
REARING HOUSE AIR VELOCITY STANDARDS AND OPERATING PRESSURE STANDARDS

The pressure readings will increase from the front to the extraction end of the house. The pressure reading at the extraction end is an indication of the amount of work the fans must do to move the air down the length of the house. It is the sum of the following pressure drops:

1. evaporative pad pressure drop
2. tunnel inlet light trap pressure drop
3. transition or "squeeze" pressure drop
4. pipe pressure drop, (including resistance created by objects such as nest boxes and feed hoppers)
5. tunnel fan light trap

Estimated fan operating pressures for 120 m (400 ft) rearing houses operating at 2.0 m/s (400 fpm) with and without evaporative pads:

Pressure Source	Pressure (Pa)	Pressure (in wc)
Evaporative pad pressure drop	12.5	0.05
Tunnel inlet light trap pressure drop	5.0	0.02
Transition pressure drop	5.0	0.02
Estimated pipe pressure drop	3.4	0.014
Tunnel fan false wall light trap pressure drop	20.0	0.08
Total fan operating pressure with evaporative pads	45.9	0.18
Total Fan operating pressure without evaporative pads	33.4	0.13



Total fan operating pressure *with* evaporative pads 45.9 Pa (0.18 in wc)
Total fan operating pressure *without* evaporative pads 33.4 Pa (0.13 in wc)

A rearing house without evaporative cooling should ideally operate at about 37 Pa (0.15 in wc) in full tunnel mode. In reality this can be achieved only if the house is designed for 2 m/s (400 fpm), but is very difficult to achieve if an air velocity of 2.5 m/s (500 fpm) is needed. If an evaporative cooling system is installed, and air velocity is increased to 2.5 m/s (500 fpm), the house operating pressure will be more than 50 Pa (0.25 in wc) in full tunnel ventilation.

LIGHT TRAP SIZING EXAMPLE – REARING HOUSE WITHOUT EVAPORATIVE PADS

Information needed from equipment suppliers includes:

A. Tunnel fan capacity at pressure to ensure required air speed is achieved

B. Light trap pressure and face velocity curves – these will be used to calculate light trap area requirement

A. *Tunnel fan capacity at pressure to ensure required air speed is achieved*

Rearing house dimensions for this example: 120 m × 12 m × 2.4 m (cross section area – 29 m^2)
400 ft × 40 ft × 8 ft (cross section area – 320 ft^2)

Tunnel fans in this example: Cone fan 1.44 m (57 in)

Test results for example tunnel fan (from BESS lab)

Static pressure (in wc)	Air flow volume (cfm)	rpm	volts	amps	watts	cfm/watt	Static pressure (Pa)	Air flow volume (m^3/hr)	(m^3/hr)/W	W/1000m^3/hr
0.00	32600	530	230.5	4.77	1302	25.0	0	55400	42.6	23
0.05	30900	528	229.4	4.92	1388	22.2	12	52400	37.8	26
0.10	28800	526	230.3	5.09	1470	19.6	25	49000	33.3	30
0.15*	26500	524	229.6	5.25	1549	17.1	37*	45000	29.1	34
0.20	23700	522	229.0	5.39	1618	14.6	50	40200	24.8	40
0.25	20100	521	230.6	5.51	1673	12.0	62	34100	20.4	49
0.30	14500	520	230.3	5.57	1704	8.5	75	24700	14.5	69

Test results indicate the fan runs at 45,000 m^3/h at 37 Pa (26,500 cfm at 0.15 in wc).

*(*To ensure reliable results, we use the fan capacity at a working pressure of 37 Pa (0.15 in wc) since it is closest to the expected total pressure. Recall from page 4 that ideal operating pressure is 37 Pa (0.15 in wc)*).

Total fan capacity needed to achieve 2.5 m/s (500 fpm)* = house cross section × air velocity

*(*Recall from page 4 house air velocity standards for a rearing house are 2.0 to 2.5 m/s (400 to 500 fpm)*).

29 m^2 × 2.5 m/s = 72.5 m^3/s ÷ 12.5 m^3/s per fan= 5.8 or 6 fans*

320 ft^2 × 500 fpm = 160,000 cfm ÷ 26,500 cfm per fan = 6 fans

**(When calculating fan numbers, always round the final number up to determine the total number of fans required. Expect fan strength to diminish over time.)*

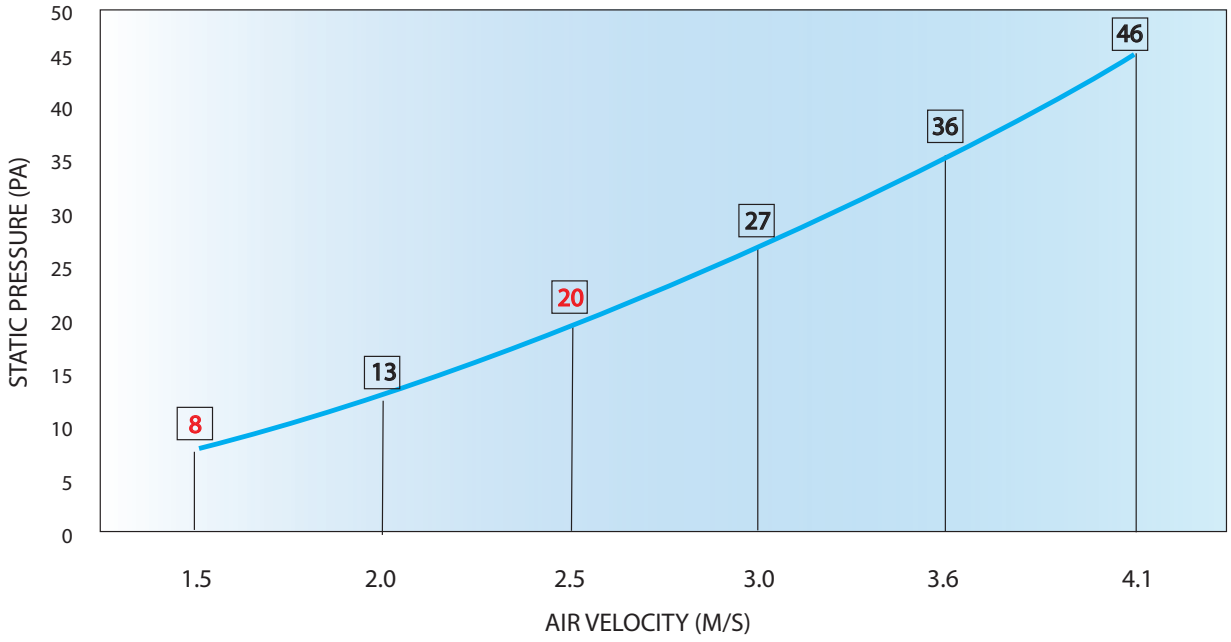
B. *Light trap pressure and face velocity curves – calculating light trap area requirement*

The graphic illustration below is an example of a BESS LAB test results for a vertical blade type light trap http://bess.illinois.edu/pdf/Lighttraps.pdf.

- The pressure drop across the light traps and light reduction factor were measured over a wide range of face velocities.
- The light trap face air velocities used for calculating the areas of light trap for both inlet and tunnel fan false wall were extrapolated from the pressure curve.

Vertical blade type light trap resistance to airflow in Pa and m/s

Light reduction factor - 1,900,000 : 1



The tunnel inlet light trap was sized at 1.5 m/s (300 fpm) with a pressure drop of 8 Pa (0.03 in wc). The tunnel fan light trap was sized at 2.5 m/s (500 fpm) with a pressure drop of 20 Pa (0.08 in wc). (See the values highlighted in red)

Note: These pressure and velocity values in the graphs are estimates of the values published by BESS LAB. The pressure and face velocities used are only close approximations – for more accurate data contact your light trap supplier.

SIZING THE LIGHT TRAPS

As a general rule both the tunnel inlet and fan false wall light traps can be sized over a range of face velocities. The tunnel inlet light traps can be sized at 1.5 to 2.5 m/s (300 to 500 fpm) and the tunnel fan false wall light traps at about 2.5 to 3.8 m/s (500 to 700 fpm). This can vary depending on suppliers and the required light reduction factor. The area of the light trap will always depend on the amount of tunnel fan capacity installed.

Sizing the tunnel inlet light trap:
Based on our standard requirements where the maximum house pressure drop should not exceed 37 Pa (0.15 in wc), the tunnel inlet and tunnel fan light traps are sized at 1.5 m/s (300 fpm) and 2.5 m/s (500 fpm), respectively.

Tunnel fan capacity installed: 6 x 12.5 m^3/s (26,500 cfm) = 75 m^3/s (159,000 cfm)

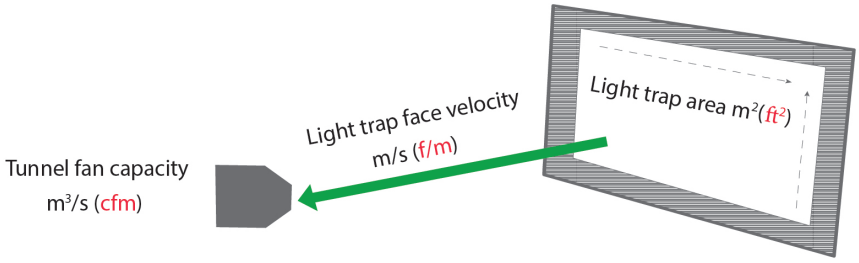
Tunnel inlet light trap area needed: 75 $m^3/s \div 1.5$ m/s = 50 m^2
159,000 cfm ÷ 300 fpm = 530 ft^2

Tunnel fan light trap area needed: 75 $m^3/s \div 2.5$ m/s = 30 m^2
159,000 cfm ÷ 500 fpm = 318 ft^2

Potential problem: The cross section of the house used in the example is: 29 m^2 (320 ft^2). Installation of 30 m^2 (332 ft^2) of tunnel fan light trap false wall will be impossible since the light traps need to be mounted on a concrete stem wall above the litter. This problem will be further compounded in a combined rearing and production house with slats.

Solution: An alternative is to install the tunnel fans on the sides of the house with a plenum type room (dog house) for the installation of the light trap false walls – see light trap choices and installation tips E on page 3.

Note: when sizing a light trap to be installed across a perimeter inlet, tunnel inlet or in the light trap plenum wall in front of the tunnel fans, the area of light trap required is expressed in terms light trap face velocity; i.e. the lower the velocity, the greater the area and the lower the corresponding pressure drop will be.



Light trap area m^2 (ft^2) = Tunnel fan capacity m^3/s (cfm) ÷ Light trap face velocity m/s (f/m)

CONCLUSIONS

The choice and installation of light traps are very important when upgrading or in new builds. In many parts of the world where rearing and production are in the same house, the light traps need to be removed at light stimulation. Choosing a high quality modular light trap that can be easily dismantled and safely stored is critical. In the future, with increases in stocking densities and the need for higher air velocities in rearing, the choice and sizing of light traps will become important for successful management during hot weather.